MARS: DARK INTRA-CRATER DUNES ON A REGIONAL SCALE Tirsch, D.[1] and R. Jaumann[1], [1]Institute of Planetary Research, German Aerospace Center (DLR), 12489 Berlin, Germany; daniela.tirsch@dlr.de.

Introduction: Aeolian sand dunes are the topic of numerous scientific studies on Mars. For example, [1] provide a quantitative view of the geographic distribution of dune fields and calculated several necessary properties such as aerial extend, volume, and slip face orientation in a global scale. Local dune field analyses were made by several workers [e.g. 2, 3] who analyzed selected dune fields for grain size, dune-forming winds, volume, sediment sources, and sedimentary history in a local scale. Our analysis is situated in the middle of these two scale types. We focus on dark material occurrences on Martian crater floors by a global selection of 70 impact craters and take a special interest on the intra-crater dark dunes and dune fields. We try to bridge the gap between global and small-scale analysis by investigating local dune field properties and bring them into a global context.

Morphology: The dark material on the selected crater floors can be found in various different deposition types. These can be single dunes, multiple dunes coadunated to huge complex dune fields, but also thin sand sheets. The dune morphology is very diverse (Fig 1): Barchan, barchanoid, and transverse dunes are the most common dune types, but also star dunes, linear dunes and dome dunes can be found on Mars [e.g. 1, 4-7]. The global view of dune type distribution shows that it follows no specific geographically driven aspects but depends on local topography, wind regime, and sediment supply. Figure 2(a) shows that barchan and barchanoid dunes can be found in most of the analyzed localities. Transverse, linear, and star dunes occur more seldom and are preferably situated in huge complex dune fields of the southern cratered terrain. Note that these latter dune types coexist with barchan or barchanoid dunes in most cases. Sand sheets are deposited where the sediment supply is too low for the deposition of aeolian bed forms such as it is in the Thaumasia region and the northern lowlands.

Wind regimes: In most cases, the dune shape is a good indicator for the formative wind regime. For example, barchan dunes develop in unidirectional winds, while linear dunes or seif dunes develop in bidirectional wind regimes [8]. This information is useful for answering the question if the dunes are influenced be current winds or if they were built by paleo wind regimens. In general, if the dune slipface deduced wind directions coincide with current winds, it could be an indicator for recent aeolian dune forming processes [9]. Thus, we compared the morphology deduced wind directions with modeled yearly maximum winds from the Mars Climate Database

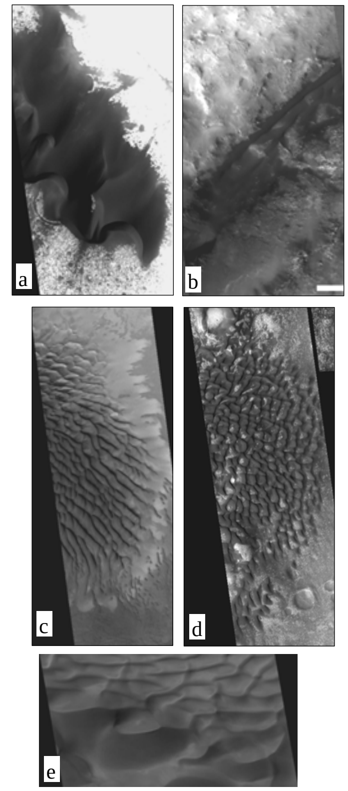

Fig. 1: (a) Barchan dunes in a small crater in Arabia Terra (subset of MGS/MOC image E2200514); (b) Linear dune in Dawes crater (subset of MGS/MOC image 1101900); (c) Transverse dunes in Lyot crater (subset of MGS/MOC image M1800073); (d) Barchanoid dunes in Moreux crater (subset of MGS/MOC image E0100550); (e) Star dunes in a small crater near Argyre Planitia (subset of MGS/MOC image R1501756).

(MCD) [10, 11] for every crater location. The results are shown in figure 2(b), providing a global overview of places where the slipface deduced wind directions coincide with current winds and where not. The maximum wind speeds modeled in the 3.7°/5.6° latitude/longitude grid for 10m above the surface are around 19 s/m. However, [12] established the minimum friction threshold velocity needed to lift sand sized particles on Mars to be 2.2 m/s. This friction velocity corresponds to wind speeds higher than 45 m/s [13]. Thus, the modeled yearly maximum wind speeds are not high enough to initiate saltation. This indicates that unconsolidated dune sands could only be influenced by much stronger winds, at most occurring during dust storm events. These infrequent basic conditions for particle motion (and thus for dune movement) is consistent with several observations that a proportion of Martian dunes seem to be immobile (at least seasonally) [e.g. 5, 14, 15], and is also consistent with small number of observations of moving dunes [e.g. 3, 7]. Finally, it is not possible to make assumptions about the current wind influence on dunes by the comparison with these yearly maximum wind speed data.

Mineralogy: Analyses of OMEGA near infrared spectra reveal a mafic composition for all the examined dark materials (fig. 3). A detailed description of this analysis is given in [16, 17]. Figure 2(c) provides an overview of the global distribution of the mineralogy of the studied dark material occurrences. Pyroxene is the predominant mineral, while olivine absorptions were only found in 13 of the 70 localities. These unoxidized mafics point to a mechanical weathering of the material without aqueous alteration. However, absorption features pointing to the presence of hydrated minerals (likely phyllosilicates) gives evidence for a chemical alteration of the material in some places. These localities cluster in Arabia Terra. Except of the hydrated minerals, there is no obvious correlation between the geographical location and the mineralogical composition of the mark material. This leads to the conclusion that all the dark materials in Martian craters are in the whole of the same composition and thus might have the same origin.

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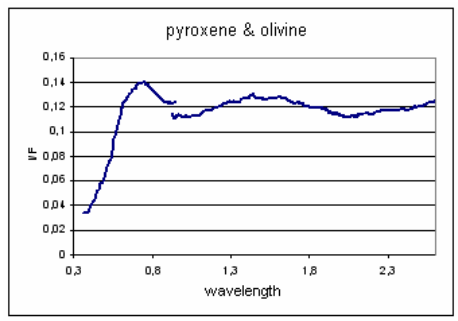

Fig. 3: Typical OMEGA reflectance spectrum of dark material showing pyroxene and olivine absorption features (ORB0295_5).

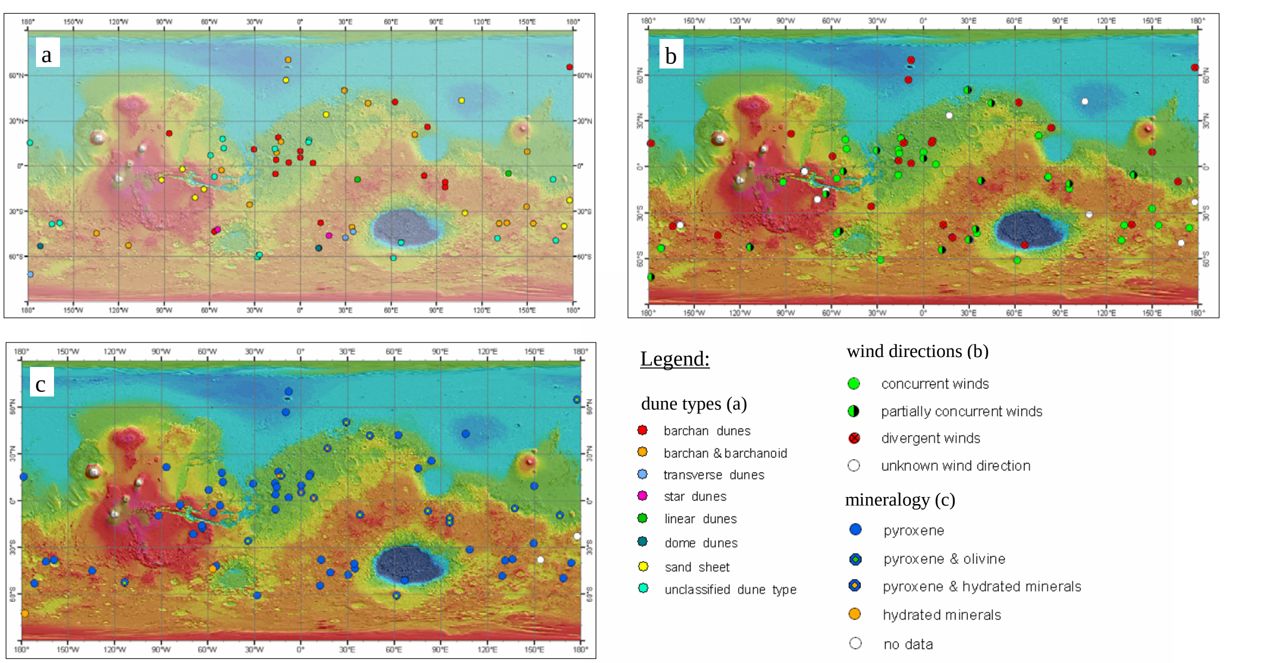

Fig 2: Global consideration of (a) dune types, (b) wind direction comparison, and (c) mineralogy of dark material in the studied craters.